DRAFT

THE BIOLOGIC ASSESSMENT OF CHLOROBENZILATE

A report of the CHLOROBENZILATE assessment team to the rebuttable presumption against registration of Chlorobenzilate.

United States Department of Agriculture

In cooperation with

State Agricultural Experiment Stations
Cooperative extension Service
Other State Agencies
U.S. Environmental Protection Agency

Technical Bulletin ____________________

PREFACE

This report is a joint project of the U.S. Department of Agriculture, the State Land-Grant Universities, and the U.S. Environmental Protection Agency, and is the ____ in a series of reports prepared by a team of scientists from these organizations in order to provide sound, current scientific information on the benefits of, and exposure to, chlorobenzilate.

The report is a scientific presentation to be used in connection with other data as a portion of the total body of knowledge in a final benefit/risk assessment under the Rebuttable Presumption Against Registration Process (RPAR) in connection with the Federal Insecticide, Fungicide, and Rodenticide Act.

This report is a slightly edited version of the report prepared for submission to the Environmental Protection Agency (EPA). The editing has been limited in order to maintain the accuracy of the information in the original report. Delete

Sincere appreciation is extended to the Assessment Team Members and to all others who gave so generously of their time in the development of information and in the preparation of the report.

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SUMMARY

This report presents the biological and exposure information related to the uses of chlorobenzilate as gathered by the USDA/State/EPA Biological Assessment Team. A USDA/State economic analysis report will be issued separately, even though EPA did one of their own in May of 1977 (11).

Chlorobenzilate has been used as an agricultural pesticide for 30 years. It is registered on 54 different sites of application for the control of mites. The basic U.S. producer and prime registrant is CIBA-GEIGY Corporation, Agricultural Division, Greensboro, North Carolina. Chlorobenzilate has been formulated as a dust, wettable powder, emulsifiable concentrate, and as a technical material. It is presently registered for, and has a tolerance on, 14 feed/food crops. It is also registered for use on cotton, ornamentals, premises, trees, shrubs, and turf.

The primary use of chlorobenzilate is for mite control on citrus and is the basis for the bulk of this report. Other food uses as identified by the assessment team include fruits, melons, and nuts.

Chlorobenzilate is readily used and recommended on citrus in California, Florida, and Texas. Arizona, since moving into an IPM approach on citrus, now recommends the use of chlorobenzilate. Chlorobenzilate was probably the prime material used by the PCO industry for the control of clover mites infesting premises (outside). Chlorobenzilate use on cotton was identified as the second highest area of use, ornamentals were identified as the third highest area of use, followed by all other uses.

Chlorobenzilate is a specific miticide and therefore is not harmful to predators and parasites of many citrus pests, especially two wasps (*Aphytis* spp.) that control two scale pests in Florida. Chlorobenzilate is only slightly hazardous to two predatory mites (*Amblyseius* spp., *Typhlodromus* spp.). Chlorobenzilate is also not detrimental to bees under field conditions. In fact, it has been used to control an acarine disease (the tracheal mite) in bees. Therefore, chlorobenzilate can be applied at almost any time.

Environmentally, chlorobenzilate is quickly broken down in the soil by the soil microorganisms, especially a yeast. Residues are not usually expected to accumulate in fat, milk, or meat according to residue tests. Although chlorobenzilate residues concentrate in citrus rinds, residue studies indicate that products such as candies, marmalade, or orange juice showed no significant residues that would contribute to the increase of residues in a person's diet.

Environmental exposure, especially exposure to humans, from the presently registered uses of chlorobenzilate are low. People involved in the manufacture of chlorobenzilate have been monitored by medical personnel, and have been found to have no problems. Exposure from applications of the product, especially to trees which represent the maximum possible exposure situation under use conditions, again has not indicated any problem areas. Safeguards, such as protective clothing, can further reduce field exposures during application, and as is always the case with any pesticide, following label directions is essential.

Conclusions

Based on the review of the assessment team, the following uses for chlorobenzilate should be retained:

Citrus Uses - Retain all registered uses for all citrus products in the States of Arizona, California, Florida, and Texas. Chlorobenzilate is essential in these areas, especially where IPM programs are being implemented or have already been implemented.

Noncitrus Uses - Resistance to alternative miticides is becoming a widespread problem. Chlorobenzilate is needed in these areas. Therefore, registrations for chlorobenzilate should be continued on almonds, cherries, cotton, melons, ornamental/lawns, outdoor areas (premises, and others), and walnuts.

A great deal of specific data are lacking on occupational exposures by agricultural workers working with chlorobenzilate treated commodities. It is proposed that an 18 month period be granted during which time additional studies can be run and the data analyzed before regulatory actions are taken.

Protective clothing, respirators, and gloves protect applicators when they are applying chlorobenzilate; however, the assessment team feels these devices would not always be used in the hotter climates, especially where citrus is treated, because of the extreme discomfort to the user. It was felt that chlorobenzilate should be classified as a "Restricted Use" pesticide, and that

protective clothing and devices be recommended, but not made mandatory. Wording contained in the USDA/EPA publication "A Guide for Commercial Applicators" (Page 5-2) should be used in these suggestions.

In regard to dietary exposure, calculations should be made on actual residues found; it should not be assumed that all samples contain the maximum possible residues. There are sufficient data, at present, to indicate that most chlorobenzilate residues are at trace levels even in the citrus and citrus byproduct areas, and calculations should be made accordingly.

CONTENTS

BIOLOGIC ASSESSMENT

INTRODUCTION

Purpose of Report

The purpose of this report is to collate the biological, exposure, and other data collected by the assessment team as it relates to the uses of chlorobenzilate. The report was prepared as a source of information that was used by the assessment team to evaluate the benefits and risks to humans, animals, non-target organisms, and the environment resulting from the registered uses of chlorobenzilate as an acaricide (miticide) on citrus, cotton, fruits, lawns, melons, nuts, ornamentals, premises (outside), and shurbs.

This information was provided to the U.S. Environmental Protection Agency (EPA), not in this consolidated form, but in a draft form, addressing primarily the citrus situations in California, Florida, and Texas (1)[1/]. The total information contained in this report was used as a basis to prepare the U.S. Department of Agriculture's response to EPA concerning the chlorobenzilate RPAR in a letter from the Secretary of Agriculture to EPA dated August 2, 1978 (2).

[1/] Figures in parentheses refer to the references at the end of this publication.

Chlorobenzilate RPAR Triggers

Title 40, 162.11, of the Code of Federal Regulations for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as ammended (86 Stat. 971,89 Stat. 751, 7 U.S.C. 136 etseq.) provides that a rebuttable presumption against registration (RPAR) or reregistration shall arise if the Environmental Protection Agency (EPA) determines that the pesticide meets or exceeds any of the risk criteria relating to acute or chronic toxic effects set forth in the Regulations (Section 162.11 (a)(3)). A notice of RPAR is issued when the evidence related to risk meets the criteria set forth.

In the Federal Register of May 26, 1976, EPA issued a notice of rebuttable presumption against registration and continued registration of pesticide products containing chlorobenzilate (18). In this instance the EPA determined that chlorobenzilate may have met or exceeded the risk criteria for oncogenic effects and chronic toxicity. Available data indicated that chlorobenzilate induces oncogenic effects in mice as a result of oral exposure, and may be oncogenic in rats as a result of oral exposure. Chronic effects were also noted in a long-term study involving both sexes of Carworth Farm rats (18).

History of Use and Usage

Chlorobenzilate was first synthesized by F. Hofliger, J. R. Geigy S.A., Basle, Switzerland, and introduced as a specific acaricide in 1952 (10). Commercial formulations were available as a 4 percent dust, 25 percent wettable powder, a 2- or 4-pound active ingredient emulsifiable concentrate, and as a 94 percent technical material (21). The principal formulation today is the 4-pound active ingredient emulsifiable concentrate. Chlorobenzilate is usually formulated alone but has been formulated in combination with other pesticides, and it is often tank mixed (21). The principal formulator/registrant in the United States is CIBA-GEIGY Corporation, Greensboro, North Carolina. Registrants or applications for registration of chlorobenzilate in the United States and affected by this RPAR are listed in table 1.

Table 1.--Chlorobenzilate registrants/applicants in the United States[1/]

Registrant/Applicant	EPA Registration No(s).	Location
Aceto Chemical Company	2749-155 2749-GUU 2749-UNO	Flushing, New York
Agan Chemical Mfg. Ltd.	11603-12	c/o Solcoor, Inc. New York, New York
Agrico Chemical Company	3238-9137 (FL ST.)	Tulsa, Oklahoma

Table 1--Continued

Registrant/Applicant	EPA Registration No(s).	Location
American Refining and Manufacturing Company	34164-9254 (FL ST.)	Miami, Floria
AR Chemical Corporation	7122-95	Portsmouth, Ohio
Chempar Chemical Corporation	7173-RGA	New York, New York
CIBA-GEIGY Corporation	100-332 100-424 100-458 100-490 100-533	Greensboro, North Carolina
Consolidated Chemical Company	38329-R	Denver, Colorado
Crystal Manufacturing Corporation	9663-23	
Hahn Exterminating Service	9962-1	Mansfield, Ohio

Table 1--Continued

Registrant/Applicant	EPA Registration No(s).	Location
Helena Chemical Company	5905-3102 5905-7018 5906-7880 (all FL ST.)	Memphis, Tennessee
Makhteshim Beer Sheva Chemical Works, Ltd.	11678-13	c/o Solchem, Inc. New York, New York
Marubenc America Corporation	9566-G	c/o Donald Lerch Washington, D.C.
Rose Exterminating Co.	30257-8881 (OH ST.)	Cleveland, Ohio
Selco Supply Company	1348-149	Eaton, Colorado
Shama Company, Inc.	20178-1	N. Plainfield, New Jersey
Tex Ag. Company, Inc.	33722-3270 (TX ST.)	Mission, Texas

Table 1--Continued

Registrant/Applicant	EPA Registration No(s).	Location
Thompson-Hayward Chemical Company	148-1164	Kansas City, Kansas
Tower Chemical Company	9518-2 9518-U 9518-10380 (FL ST.)	Clermont, Florida
Trans Chemic Industries	9618-15 9618-21	Penn Plaza, New York

1/ Source (18,19,20).

Chlorobenzilate is registered as a miticide on citrus, cotton, dwellings (outside), fruits, lawns, melons, nuts, ornamentals, shrubs, and trees. The assessment team addressed all of these uses, but it was quickly determined that the major use of chlorobenzilate was on citrus. CIBA-GEIGY estimates that the citrus use of chlorobenzilate in the United States is 97 percent (5). The use on citrus was so extensive that the USDA was formally invited by EPA to assist in the evaluation of chlorobenzilate as a miticide for citrus crop uses in September 1976 (14).

This invitation even contained a list of suggested personnel that could assist in the project from the States of Arizona, California, Florida, and Texas. Subsequent to this, the formal USDA/State assessment team had been formed.

EPA lists 20 registrants or prospective registrants for chlorobenzilate (18,19,20) in the U.S. [review table 1], with 26 products registered on 54 separate sites of application (21). There are also 14 tolerances approved for chlorobenzilate on feeds and/or foods (6).

PROPERTIES OF CHLOROBENZILATE

Physical and Chemical Properties

The pure compound is a yellowish, viscous liquid having a boiling point of 141° to 142°C at 0.06 mm of Hg. The vapor pressure is 2.2×10^{-6} mm of Hg at 20°C, and 1.4×10^{-4} mm of Hg at 60°C. The technical product contains approximately 93-94 percent of the above compound, is a brownish liquid with a specific gravity of 1.2816 at 20°/4°, and weighs 10.7 pounds/gallon. Chlorobenzilate is virtually insoluble in water, but is infinitely miscible in benzene, acetone, methyl alcohol, xylene, and deodorized kerosene. Under normal storage conditions, chlorobenzilate is stable, whether stored as the technical material, as a wettable powder, or as an emulsifiable concentrate (10). Other pertinent information is as follows:

Common name: chlorobenzilate

Chemical name: ethyl 4,4'-dichlorobenzilate

Trade names and other names: Acaraben®, Akar, CAS 510-15-6, ENT-18596, G-23992

Empirical formula: $C_{16}H_{14}Cl_2O_3$

Molecular weight: 325.18

Toxicology

The acute, oral, dermal, and inhalation toxicity values of chlorobenzilate to mice, rats, and rabbits are presented in table 2. In addition, the LC_{50} values (grams per day dietary) are 3375 p/m for bobwhite quail, and >8,000 p/m for mallard ducks. The LC_{50} (96 hour) values are 0.6 p/m for rainbow trout, 1.8 p/m for bluegill sunfish, and 0.7 p/m for goldfish (5).

Fate of Chlorobenzilate

Residues of concern from foliar applications of chlorobenzilate are those that remain in or on the commodity being treated as they could possibly be present during human consumption. The tolerances established by the U.S. Food and Drug Administration for chlorobenzilate in or on foods and feeds are presented in table 3. The acceptable daily intake (ADI) established by FAO/WHO

Table 2.--Acute oral, dermal, and inhalation toxicities of chlorobenzilate[1/]

Animal	Route	Formulation or solvent	LD_{50} (mg/kg body-weight)[a,b,c]
Mouse	oral	suspension in gum arabic	4,850
Mouse	oral	25 pct wettable powder	3,200
Mouse	oral	technical	729
Rat	oral	suspension in gum arabic	3,100
Rat	oral	technical	702
Rat	oral	25 pct xylene emulsion	735
Rat	oral		M 1,040; F 1,220
Rabbit	dermal	4E (45.5 pct emulsifiable sol.)	>5,000
Rabbit	dermal	25 pct wettable powder	>2,550
Rat	aerosol inhalation	4E; undiluted	LC_{50}c<49 mg./1 air
Rat	aerosol inhalation	4E; 0.2 pct aq. sol.	LC_{50}c>21 mg./1 air
Rabbit	eye irritation test	25 W; 50 mg. of undiluted test material instilled into the conjunctive sac	moderately irritating
Rabbit	eye irritation test	4E; 0.1 ml. of undiluted test material instilled into the conjunctival sac	severely irritating

[1/] Source (10).

[a/] All values are expressed in terms of active ingredient.

[b/] The symbol > means that the LCD_{50} is higher than the quoted figure, i.e., the highest tested.

[c/] The LC_{50} values are expressed in terms of the formulation used based on a four-hour exposure.

is 0.02 mg/kg of body weight. This means a 60 kg person would tolerate a daily dosage of 1.2 mg of chloribenzilate without appreciable risk (23).

Table 3.--Chlorobenzilate tolerances[1/]

Commodity	P/m
almonds	0.2
almond, hulls	15.0
apples	2.0
cattle, fat	0.5
cattle, meat	0.5
cattle, meat byproducts	0.5
citrus fruits	5.0
cotton, seed	0.5
melons	5.0
pears	5.0
sheep, fat	0.5
sheep, meat	0.5
sheep, meat byproducts	0.5
walnuts	0.2

1/ Source (6).

Chlorobenzilate has been given orally to cattle, dogs, and sheep in their diet. In dogs, it was determined that chlorobenzilate is absorbed by the kidneys and rapidly excreted in the urine, with only small amounts found in the feces. It was also determined that chlorobenzilate was not stored in the blood, liver, kidney, fat, muscles, or brain of these dogs. Cattle and sheep were also fed chlorobenzilate in their diets. The subcutaneous fat, omental fat, perirenal fat, muscle, liver, heart, kidney, and blood were analyzed. Residues of unchanged chlorobenzilate were found in the fat sample of cattle only. These samples came from the cattle that were fed at the highest feeding level of 340 mg/animal/day. Citrus pulp may be used for cattle feed (estimated by EPA to be up to 20 pct of the total diet for dairy cattle), and it is known that chlorobenzilate residues may tend to concentrate in the peel of citrus (5,13). However, residue studies of miscellaneous products made from citrus products high in peel or rind content again showed a low residue picture (table 4). Milk samples showed 0.15 p/m in one each of the higher and middle levels fed cows at the second and fourth days of sampling. By the 15th day, no more than 0.06 p/m was detected. These values were near the limit of sensitivity of the method and equipment used for analysis at that time (10). Residues for citrus are calculated on the whole fruit basis and have ranged from 0.05 to 2.3 p/m (1.5 p/m when control values were subtracted). The established tolerance for citrus (table 3) is 5 p/m (5).

Table 4.--Residues in miscellaneous citrus products[1/]

Item	p/m	Percent part of diet	p/m Contributed to daily diet [2/]
Marmalade	0.493	0.01	0.00005
Citrus-flavored candies	0.493	0.01	0.00005
Orange juice (frozen concentrate)	0.132 (if 2.0 = 0.0024)	1.0	0.0013
Citrus drinks	0.0816	0.01	0.00000816
		TOTAL	0.00140816

1/ Source (13).

2/ Based on tolerance of 5.0 p/m chlorobenzilate in citrus, where under actual conditions residues do not exceed 1.5 p/m.

The same is generally true for apples, melons, and pears (review Table 3), and residue samples have not approached their tolerance levels (5). The market basket surveys showed that chlorobenzilate is not present in fruit at levels greater than the method of sensitivity (only up to 0.10 p/m). Chlorobenzilate has not been shown to bioaccumulate (5). The direct exposure of humans to chlorobenzilate residues in raw or processed foods is unlikely, and only trace amounts could possibly be present in milk and fat tissues from cattle that consume citrus pulp as part of their diet. The ADI (theoretical) for adults is 0.0023 p/m, and for infants is 0.011 p/m (5).

Soil and water have been monitored (5). Chlorobenzilate, when added to the soil, is degraded to dichlorobenzilic acid and then to dichlorobenzophenon. The half-life is from 1.5 to 5 weeks (under field and greenhouse conditions) with the final product being a phenone derivative (5). Leaching was not significant; no residues were detected below 5 cm (5). Water monitoring in Florida indicated that chlorobenzilate is not mobile in the environment and is not a contaminant of water and sediments (5).

Microorganisms were evaluated for their ability to degrade chlorobenzilate. They all played a role, but a yeast, Rhodotonula gracilis, was responsible for the most rapid degradation (5). Again, based on these studies, the degradation of chlorobenzilate seemed to be from the parent compound to the acid form to the phenone form (5).

BIOLOGICAL INFORMATION

Pest Information

Chlorobenzilate is a specific miticide and the following information is applicable to all of the commodities on which chlorobenzilate is registered. Mites, as they pertain to specific commodities, are listed in table 5.

Spider (red) mites, in the family Tetranychidae, include the Atlantic (strawberry), brown, citrus red, flat, European red, McDaniel, pacific, Schoene, sixspotted, Texas citrus, and twospotted species. Their life cycles are similar. These mites usually overwinter in the egg stage or as hibernating females in protected locations. The eggs are laid on the host plant, and during the summer they hatch in 4 to 5 days. There are four instars and development from egg to adult takes about 2 to 3 weeks (3,12). The color of the immature stages and adult stages is seldom red, but the "red" nomenclature has remained over the years. Males develop from unfertilized eggs and females from fertilized eggs (3). In periods of hot, dry weather the leaves of the host plant become blotched with pale yellow and reddish-brown spots on both the upper and lower portions of the leaves. These leaves become sickly in appearance and gradually die and drop. The undersurfaces of the leaves appear as though they had been lightly dusted with fine white powder. When examined with a hand lens, the white specks are seen to consist of empty wrinkled skins and minute spherical eggs suspended upon almost invisible strands of silk. Upon this silk, and beneath it and on the surface of the leaf, numerous mites of various sizes

Table 5.--Mites controlled by chlorobenzilate 1/

Common name	Scientific name 2/	Distribution	Commodity
Atlantic [strawberry] spider mite	Tetranychus turkestani Ugarov & Nikolski	Eastern U.S.	Cotton
brown [clover] mite 3/	Bryobia arborea Koch	Northern Southwestern U.S. and Canada	almonds, apples 4/, ornamentals/lawns
cherry rust mite	Aculus spp. and Phyllocoptes spp.	similar to citrus rust mite	cherry
citrus bud mite	Eriophyes sheldoni Ewing	California only	citrus
citrus red mite	Panonychus citri (McGregor)	California and Florida	citrus
citrus rust mite	Phyllocoptruta oleivora (Ashmead)	Gulf States, limited area of California	citrus

Table 5.--Continued

Common Name	Scientific Name[2/]	Distribution	Commodity
European red mite	Panonychus ulmi (Koch)	NE and NW U.S., north of latitude 37°N	almonds, apples, walnuts
flat mite [citrus]	Brevipalpus lewisi McGregor	California	citrus
McDaniel mite	Tetranychus modanieli (McGregor)	Michigan, North Dakota and West	apple
Pacific spider mite	Tetranychus pacificus McGregor	Michigan, North Dakota and West	apple
purple mite	Panonychus citri (McGregor)	see citrus red mite, (purple mite in Florida)	citrus

Table 5.--Continued

Common Name	Scientific Name[2/]	Distribution	Commodity
Schoene mite	_Tetranychus_ _schoenei_ McGregor	Southeast U.S.	cotton
sixspotted mite	_Eotetranychus_ _sexmaculatus_ (Riley)	Florida and Gulf States limited areas in California	citrus
southern mite	_Oligonychus_ _ilicis_ (McGregor)	Southeastern U.S.	ornamentals/lawns
spruce spider mite	_Oligonychus_ _ununguis_ (Jacobi)	Throughout U.S., Canada	ornamentals/lawns
Texas citrus mite	_Eutetranychus_ _banksi_ (McGregor)	Texas and Florida	citrus

Table 5.--Continued

Common Name	Scientific Name [2/]	Distribution	Commodity
twospotted spider mite	Tetranychus urticae Koch	Throughout U.S.	almonds, apples, cotton, melons, ornamentals/lawns
Yuma spider mite	Eotetranychus yemensis (McGregor)		citrus

1/ Source (12,21).

2/ Source (22)

3/ Citrus includes grapefruit, oranges, kumquats, lemons, limes, tangelos, and tangerines; ornamental/lawns include arborvitae, aster, azalea, birch, boxwood, camellia, carnation, chrysanthenum, Douglas-fir, elm, gladiolus, hawthorn, hemlock, holly, iris, juniper, lawns, lilac (Syringa), maple, marigold, oak, ornamental shrubs, ornamental trees, phylox, pine, popular, rhododendron, roses, snapdragon, spruce, willow, yew, and zinnia; clover mites are also included for control on domestic dwellings [outside] (12).

4/ Until 1957, this mite was confused with the clover mite, Bryobia praetiosa Koch, which only attacks herbaceous plants. Clover mites are important pests of lawns and outside surfaces on buildings. Occasionally they enter the home and become nuisance pests.

are resting or running about. These mites live on the sap of the plant, which the mites is obtain by piercing the plant tissue with their piercing-sucking mouthparts. The Atlantic and twospotted mites feed in definite colonies on the undersides of the leaves and can cause heavy leaf drop. The Pacific (McDaniel mite related to it) and the Schoene mites can produce populations that exceed 1,000 mites per leaf. Populations this large cause defoliation and failure of the fruit to color properly, which may also lead to premature fruit drop. The brown mite harms the host plants by sucking the sap from the buds, leaves, and twig tips. European red mite infestations result in undersized fruits of poor quality and color, and fruit buds that are greatly weakened or prevented from forming (8,12). The citrus red (purple) mite produces a silvery, speckled effect on the leaves and heavily infested leaves turn silver or brown and drop; the fruit turns gray or yellow. Injury from the Texas citrus mite is similar. This mite feeds on the upper surface of the leaves and moves more rapidly than the citrus red mite (7). The feeding of the sixspotted mite is limited to the area on the undersides of leaves where the mites are found in colonies (7,12).

The cherry rust, citrus bud, and citrus rust mites are in the family Eriophyidae. They remain in the trees throughout the year. Eggs of the citrus rust mite are laid in depressions on the fruit and leaves. The eggs hatch in 2 to 8 days with the nymphs feeding like the adults, molting twice into slender, elongated females. Generations can be succeeded by each other in 1 to 2 weeks. The mites are usually abundant by July 1. The bud mite, found in only a few counties of California, is most damaging to lemons. This mite deposits its eggs in the protected places on the tree. The eggs hatch in 2 to 6 days; the nymphs molt three times in 10 to 20 days, with the adults again being slender or wormlike in appearance (12).

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[illegible] days with the nymphs feeding like the adults, molting twice into elongate [illegible]

[illegible] females. Generations can be succeeded by each other in 1 to 2 weeks. [illegible]

[illegible] are usually abundant by July 1. The bud mite, found in only a few [illegible]

[illegible] of California, is most damaging to lemons. This mite deposits its eggs [illegible]

[illegible] places on the tree. The eggs hatch in 2 to 6 days; the nymphs [illegible]

[illegible] to 20 days [illegible] the adults again being slender or [illegible]

Use of Chlorobenzilate

Chlorobenzilate has been used wherever mites have been a problem. The geographic areas of use are illustrated in table 5. CIBA-GEIGY reports that the percentage of use of chlorobenzilate has increased almost every year from 1966-1976 (5). They also report that the major sales markets are citrus (97.3 pct), cotton (1.9 pct), and ornamentals (0.8 pct), which agrees with the findings of the assessment team (5). Table 6 presents the available figures for chlorobenzilate treated acreage for citrus.

Application Information

Application techniques, rates, and equipment are essentially alike for similar crops or commodities. Applications to citrus are made by conventional orchard-type air-blast equipment, with aerial equipment, by handgun, or with oscillating boom type orchard equipment. Materials may be applied in the dilute or concentrated form. This same equipment is generally used with the fruit tree and nut type commodities. No matter what type of equipment is utilized, the key to good control is proper coverage and proper equipment calibration. Obviously, with the mites feeding on the upper and lower leaf surfaces on buds, twigs, and stems, miticides must be applied to the upper and lower plant surfaces (complete coverage).

Table 6.--Chlorobenzilate-treated acreage (pct) 1/

	Location			
	California		Florida	Texas
Year	Lemons	Oranges	Citrus	Citrus
1971	69.3	28.4	--	--
1972	59.9	37.9	--	--
1973	47.7	51.5	--	--
1974	70.5	25.1	--	--
1975	--	--	--	90.0
1976	--	--	2/ 80.8	--

1/ Source (15,16,17).

2/ Extensive, time proven IPM program in effect.

Costs per acre can vary, depending on many factors, including the prevailing local wage rates, local material costs, equipment used, and so forth. Table 7 illustrates one set of cost comparisons for applications of chlorobenzilate to citrus in Florida.

Table 7.--Cost comparisons for chlorobenzilate applications to citrus in Florida[1/]

Type of Application	Cost/Tank [2/] Range	Average	Cost/Acre
Helicopter	--	--	$ 7.81
Dilute (X) [3/]	$ 8-16	$ 9.81	19.62
Concentrate (2X)	15-22.50	17.77	17.77
(3X)	--	25.00	12.50
(6X)	--	40.00	10.00

1/ Source (16).

2/ Based on a 500-gallon tank.

3/ Based on 1,000 gal/acres.

Florida also indicated that in 1976, $25.00 was charged for a 500 gallon tank of 4X concentration (or $12.50/acre), while aerial applicators charged $2.50/acre for a spray concentrate.

Chlorobenzilate is usually applied for mite control as a summer spray on citrus. The same is generally true for the other commodities, as mites are generally a problem in the summer months. Clover mites, however, can be a problem on almost any warm sunny day, as the weather makes them active. They crawl up on the outside of various premises to retain the heat, become noticeably the occupants (especially if they should get inside), and instantly become a nuisance pest. Applications in all cases are made either by the grower or they are custom applied. Clover mites' control, around premises, is almost always handled by the professional PCO.

Applications to the other crops are made as described above, especially to the fruit, nut, and shade trees. Boom sprayers or handguns are usually used when treating cotton, small fruits (melons), turf, and around premises. Handguns, or even compression sprayers, are utilized when treating ornamental or other localized plants or small areas. The crew sizes, worker-hours, and application exposure times, as calculated by California, are presented in table 8.

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ion exposure times, as calculated by California, are presented

Table 8.--Worker-hour requirements and exposure times for chlorobenzilate applications[1/]

Equipment	Average crew size	Estimated exposure time to treat one acre	Estimated worker-hours per acre
Aerial application	3	< 1 minute	< 0.05
Airblast ground equipment	2	15 minutes	0.5
Oscillating boom equipment	3	15 minutes	0.75
Manual spraying	4	1.5 hours	6.0

1/ Source (15).

Generally, treatment begins when mites become a problem. As indicated from the life cycles of the various mites, they generally become a problem in the summer months on most commodities, especially when the weather is hot and dry. Directions for use indicated that repeat applications should be made if the initial application is severe or if conditions are favorable for mite buildups. Label recommendations are generally based on a dilute spray (rate per 100 gallons of water) or pounds of product per acre. Rates range from 0.15 to 0.375 lb a.i./100 gal of water for the citrus, fruits, nuts, and ornamental commodities; to 1 lb a.i./acre for such commodities as cotton and melons.

Protective clothing is not specified on the earlier labels. Users are cautioned to keep the material out of the reach of children; it is harmful if swallowed or the mist is breathed. The material should not get into the eyes or on the skin. In these situations, as with contaminated clothing, the individual should wash immediately, change clothing, and wash the clothing.

Chlorobenzilate is not phytotoxic to citrus, but is pytotoxic to some varieties of plants (table 9).

Table 9.--Chlorobenzilate phytotoxicity to plants[1/]

Commodity treated	Variety of other commodity to avoid
Almonds	Kapareil variety
Apples, Pears	Delicious, Jonathan, McIntosh variety of apples
Cherries	Will injure plums, prunes, peaches

1/ Source, product labels (21).

Chlorobenzilate should also not be used with highly alkaline materials, such as lime.

Posttreatment activities could cosist of reentry into the treated areas to check for mite buildup, harvesting, or reapplications of chlorobenzilate. Labels do not carry any reentry intervals other than the normal ones concerned with preharvest intervals (PHI). These are usually determined by the stage of the crop growth, such as do not apply to cotton after bolls begin to open, or do not apply to walnuts after husks begin to split. The exposure of pickers to dislodgable residues of chlorobenzilate has been investigated by Dr. McCoy, Florida Department of Agriculture. This unpublished work was reported on by CIBA-GEIGY (13). The results indicate that picker exposure to chlorobenzilate would be considerably lower than would be found with parathion.

Workers exposed to chlorobenzilate in the manufacturing facilities (McIntosh, Alabama) were investigated by the Equitable Environmental Health, Inc., firm located in Berkeley, California. Their preliminary results indicated that 240 men who have accumulated 1,688 person years in the chlorobenzilate production area have not had unusual health problems (5,13).

[illegible] should also not be used with highly alkaline materials

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[illegible] exposed to chlorobenzilate in the manufacturing facilities [illegible] Alabama) were investigated by the Equitable Environmental Health, [illegible] located in Berkeley, California. Their preliminary results indicated [illegible] have accumulated 1,585 person years in the chlorobenzilate [illegible] have not had unusual health problems (5,13).

MAJOR USES

Citrus

Since its introduction in 1952, chlorobenzilate, as pointed out by CIBA-GEIGY and confirmed by the assessment team, has found its place as a miticide for use in citrus. This product is effective against summer mite eggs (ovicide) and all postembryonic stages of most plant-injuring mites (10). Chlorobenzilate's outstanding effectiveness; its lack of adverse effects on bees, parasites, and predators; its nonphytotoxicity to citrus trees and fruit; and its apparent lack of toxicity to applicators or other workers exposed during posttreatment activities has accounted for the almost universal use of this chemical (15).

California likes to use chlorobenzilate as an "as needed" material to control mites. It is used on this "as needed" basis for citrus bud mite control, and is preferred over a petroleum oil spray, which always requires 1 to 2 applications and does not really control the problem. California also recommends chlorobenzilate for the "as needed" control of the citrus rust mite (under an IPM program in the coastal counties) and for the Yuma spider mite, which is found only in the desert areas.

In Florida, the citrus rust mite is the primary mite pest of citrus; it not only causes blemishes to the citrus rind but also reduces fruit size and causes premature fruit drop. If not held in check, this mite can so devitalize a tree that the crop yield can be reduced the next year. The pesticidal citrus control program in Florida depends on chlorobenzilate for the control of this mite because the material is an integral part of Florida's IPM program. This IPM program had been used successfully for four growing seasons prior to 1977. The program was initiated to control two scales, which are the primary pests of citrus. Chlorobenzilate is essential to the program because, while controlling the citrus rust mite, does not affect the predators and parasites of the two problem scale pests, the purple and Florida red scales. A small wasp (*Aphytis lepidosaphes*) controls the purple scale and another small wasp (*A. holoranthus*) controls the Florida red scale. The Hong Kong wasp (*A. lingnasnensis*) is also rapidly reducing populations of the citrus snow scale, another serious scale pest of citrus (16). The IPM program has been so successful that the purple and Florida red scales have been reduced to the role of minor pests (16).

In Texas, also, the citrus rust mite is the primary pest mite of citrus. Texas is also taking advantage of natural enemies to control its scale pest problems; but, as in Florida, there are no known natural enemies for the citrus rust mite. Therefore, rust mite problems must be controlled with pesticide applications. Chlorobenzilate is the main material used for the control of this mite because of its few disruptive effects, and in the long-term less pesticide is introduced into the environment. Chlorobenzilate is applied from 1 to 2.5

times per season with no adverse effects on the natural enemies of mealybugs and scales (17).

At the time of the RPAR, Arizona reported that very little chlorobenzilate was used on its citrus; but it also reported that chlorobenzilate was one of the two best materials to use [also mentioned dicofol] (9). Arizona also reported no exposure problems connected with the chlorobenzilate that was used. Arizona was moving into an IPM program and found, as did other prime citrus States, that chlorobenzilate was critical to its program (4).

Information on Other Registered Pesticide

In citrus pesticide programs, three mateials are used almost exclusively in all four of the major production States (Arizona, California, Florida, and Texas). These materials are dicofol, ethion (or ethion plus oil), and sulfur. All four States reported almost identical concerns about these materials when considered in conjunction with their IPM programs. These concerns are (4,15,16,17):

dicofol: Mites developing resistance in many areas. Identified in the increasing of progeny and altering the sex ratio of female snow scales.

ethion: A non-selective organophosphate that is toxic to bees and the predator/parasites (so not useful in their IPM programs).

sulfur: Residues were irritating to workers. Product can damage trees and fruit during periods of high temperatures. California and Florida reported adverse effects to their predator/parasite populations.

California also reported the use of petroleum oils as another alternative to chloribenzilate. In California, oil had to be applied 1 or 2 times every year, and not on an "as needed" basis as with chlorobenzilate. Oil applications could also result in a 5 to 10 percent loss in fresh market potential, cause increases in production costs/materials, and adversely affect the predator/parasite populations. This would cause a shift away from the IPM system since carbamate or organophosphate materials would have to be applied as extra treatments to bring the mite populations under control (15). The relative costs of applying chlorobenzilate and the major alternatives are presented in table 10.

Controls in the Absence of Pesticides

Some relief from overwintering mite populations can be obtained with the destruction of such weeds as pokeweed, Jerusaleum oak, Jimsonweed, wild blackberry, and wild geranium or the destruction or spraying of other host plants like violets and berry bushes, wherever they keep their green foliage

over the winter (12). These practices may be suitable on a local basis but are not considered practical on a commercial basis.

MINOR USES

As previously stated, chloribenzilate is registered for the control of various mites (review table 5) on cotton, fruits, lawns, melons, nuts, ornamentals, premises (outdoors), shrubs, and trees. The assessment team investigated these uses but did not develop any information on them. Even CIBA-GEIGY, in their sales summary, only indicated that small percentages were used on cotton and ornamentals. The PCO industry used a large amount of chlorobenzilate to treat for clover mites, but figures were not developed for this use.

Many alternatives to chlorobenzilate are available for the control of mites on the above commodities. Therefore, if EPA should decide to cancel the registered uses of chlorobenzilate, the impact was felt to be small.

RECOMMENDATIONS

The recommendations of the assessment team, as reflected in the letter from the Secretary of Agriculture to EPA (2), were to retain all registered uses of chlorobenzilate, especially on citrus. These recommendations are summarized in the Summary section of this report, page x.

Table 10.--Relative cost of chlorobenzilate and alternative treatments to citrus products in California[1/]

	Chlorobenzilate		Chlorobenzilate plus petroleum oil		Petroleum oil		Wettable sulfur		Dusting sulfur		Dicofol	
	L	O & G[2/]	L	O & G	L	O & G	L	O & G	L	O & G	L	O & G
Thorough distribution coverage[3/]							Outside Coverage		As dust			
Avg-gal/A	1500	2000	2000	--	2000	--	500	500	--	--	1500	2000
Material Cost/A-$	10-16	21	44-50	--	31-36	--	1-4	1-4	6	6	29	39
Applicator Cost/A-$	30	40	40	--	40	--	20	20	7	7	30	40
Total Cost/A-$	40-46	61	84-90	--	71-76	--	21-24	21-24	13	13	59	79

1/ Source (15).

2/ L = lemons; O & G = oranges and grapefruit

3/ Low volume or mist spray coverage costs on lemons were - avg-gal/A = $100-200; material costs = $7.00; applicator costs = $20.00; and the total cost/A = $27.00 for chlorobenzilate only.

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